The Future of Ballistic Missile Defense Technology

Dr. Charles Infosino
BMDO Chief Scientist

10th Annual AIAA/BMDO Technology Conference
Williamsburg, Virginia

23–26 July 2001

UNCLASSIFIED

BALLISTIC MISSILE DEFENSE MISSION AND TECHNICAL CHANGES 1984 - 2001

Technology Segment

	Research	Phase I	GPALS	TMD	NMD	BMDS
Time Frame	• 1984-1986	• 1987-1990	• 1991-1992	• 1993-2000	• 1998-2000	• 2001 -
Mission	• Protect Against Massive Soviet Attack	• Deterrence	• Protect Against Limited Attack	• Tactical Requirements	• Protect Against Limited Attack	• Strategic Defense
Element Focus	• DEW	• Space (SpaceBased Interceptors (SBI)	• Brilliant Pebbles • GBI	• Terminal Interceptors (THAAD)	• EKV	• Boost Segment • Midcourse Segment
Key Challenges	• Feasibility	• Survivability • Midcourse Discrimination	• Midcourse Discrimination	• Family of Systems Integration	• Midcourse Discrimination (One Tier Architecture)	• T&E • Technology Maturation

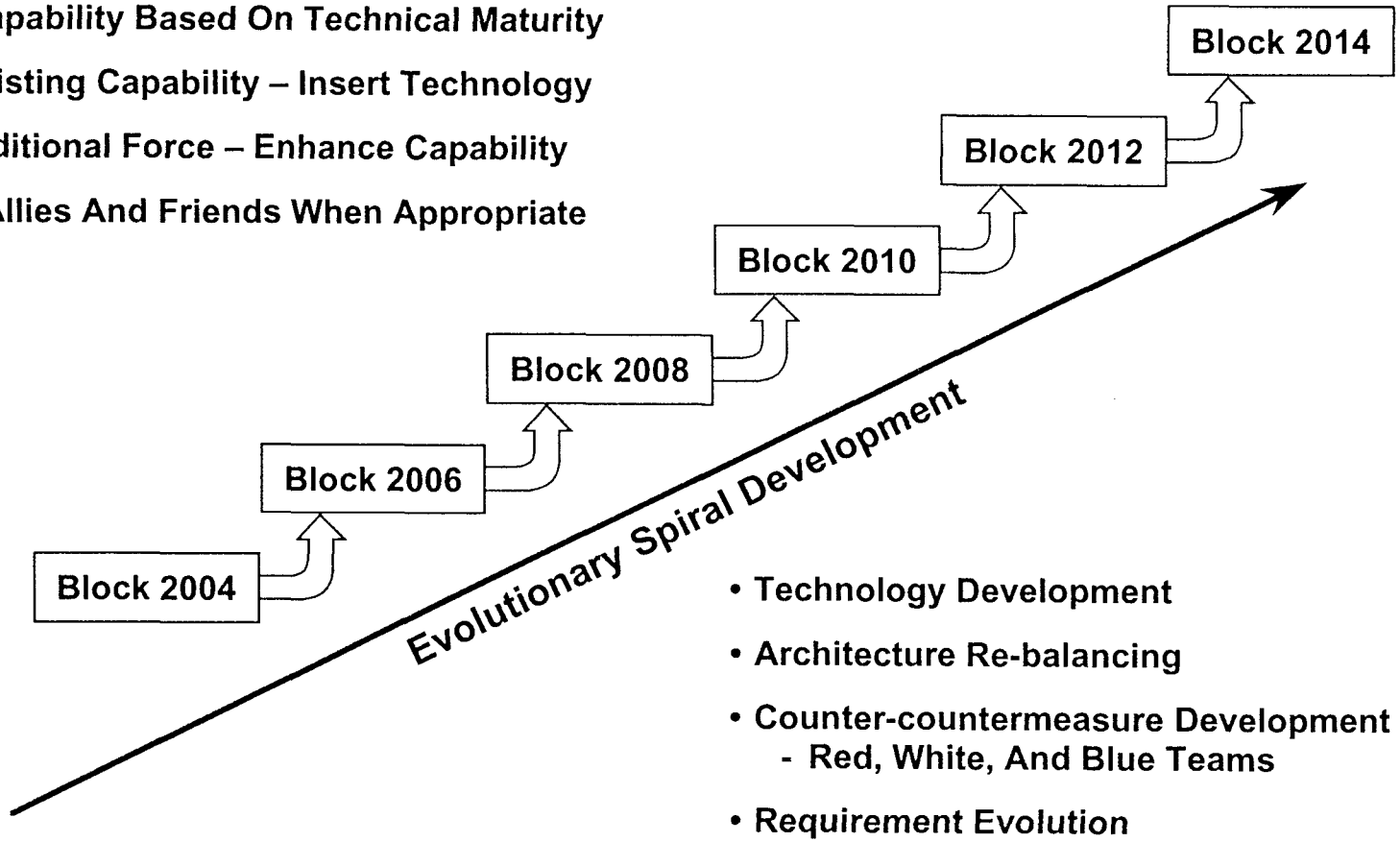
UNCLASSIFIED

BMD EVOLUTIONARY DEVELOPMENT

Technology Segment

CY	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015

- Add New Capability Based On Technical Maturity
- Upgrade Existing Capability – Insert Technology
- Procure Additional Force – Enhance Capability
- Extend To Allies And Friends When Appropriate



- Technology Development
- Architecture Re-balancing
- Counter-countermeasure Development
  - Red, White, And Blue Teams
- Requirement Evolution

mj-102514M / 071801

UNCLASSIFIED

GOALS OF BMDS PROGRAM

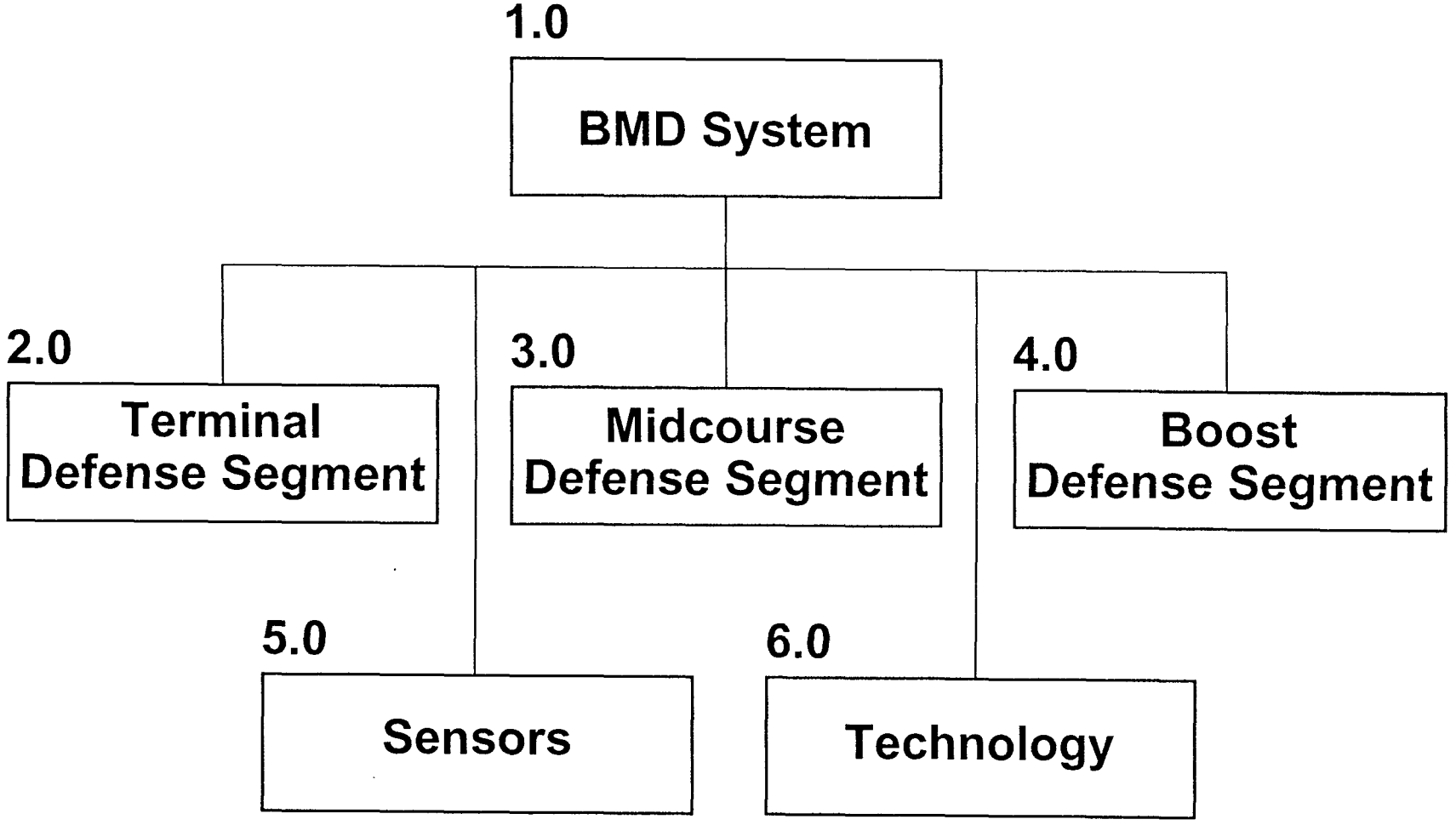
Technology Segment

- Single BMD Acquisition Program With Goal Of Deploying Incremental Capabilities As Soon As Practical
- Start With What WE Know – Build On The Technical Progress Made To Date Without Losing Focus
- Get Capability In the 2004-2008 Time Frame
- Move To A Layered Defense Soonest

UNCLASSIFIED

PROGRAM WORK BREAKDOWN STRUCTURE

Technology Segment

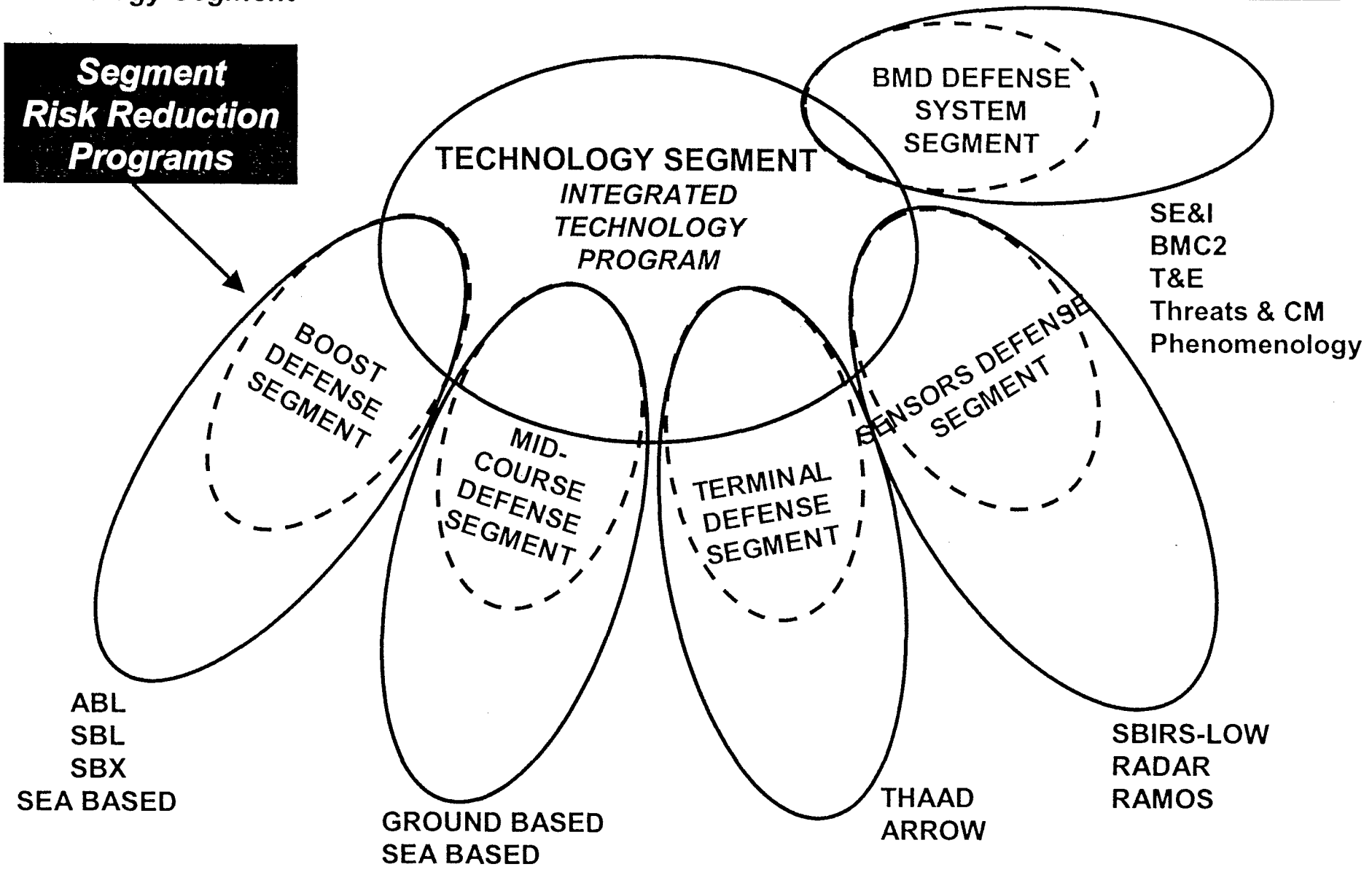


20 Program Elements ⟶ 9 Program Elements

mj-102514L / 071801

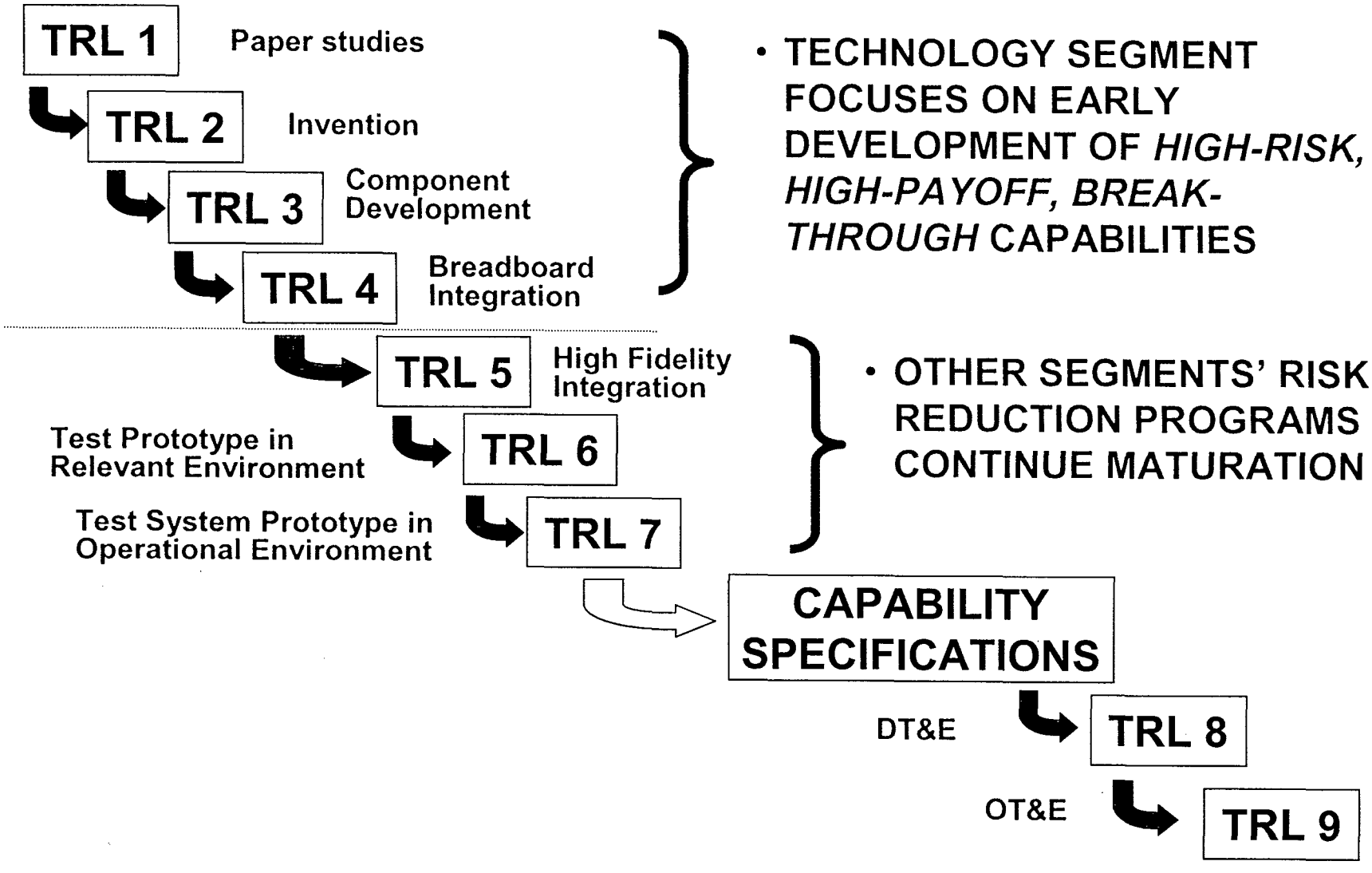
UNCLASSIFIED

TECHNOLOGY DEVELOPMENT COORDINATED ACROSS SEGMENTS



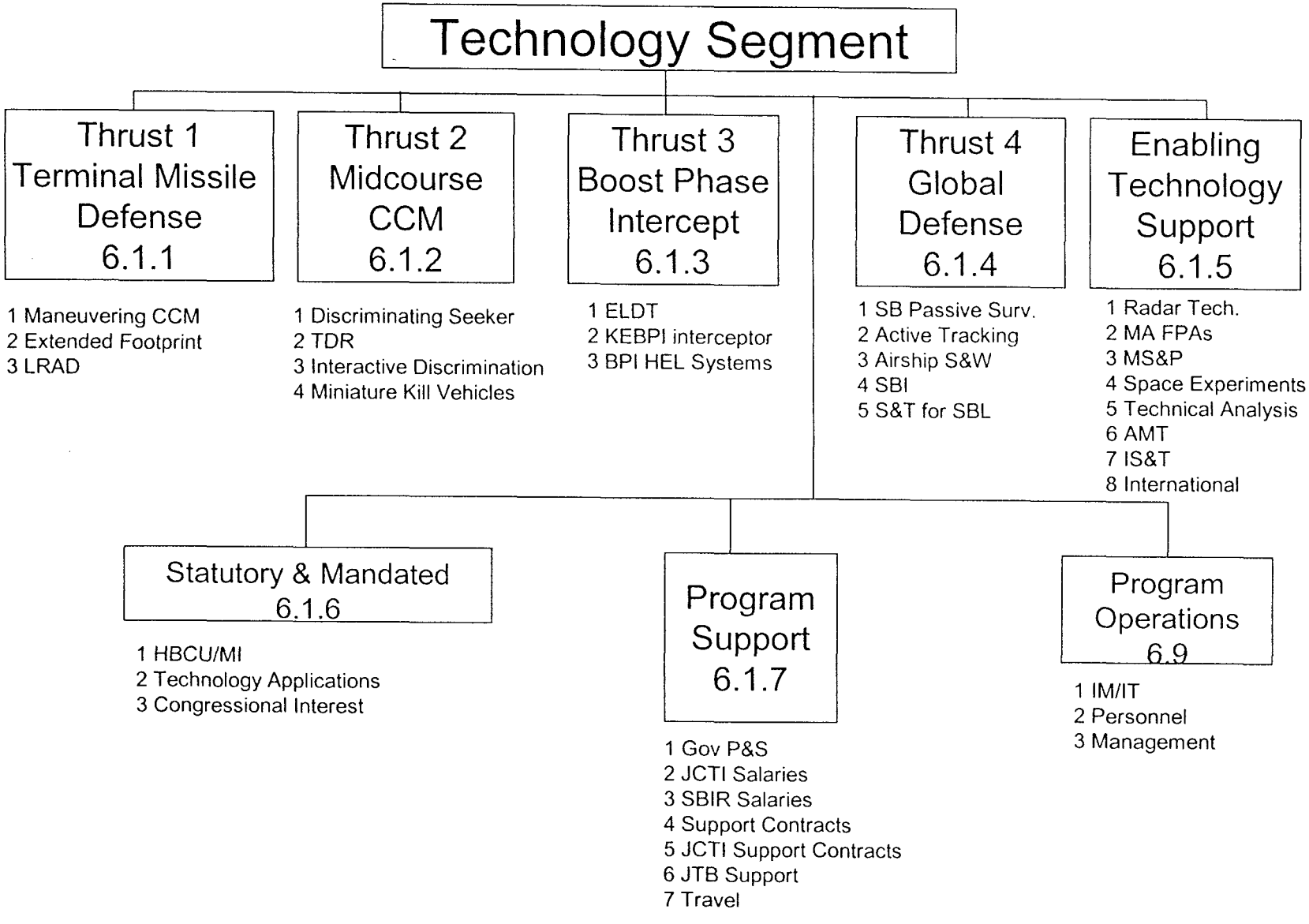
TECHNOLOGY MATURATION

Technology Segment



TECHNOLOGY SEGMENT WBS

Technology Segment



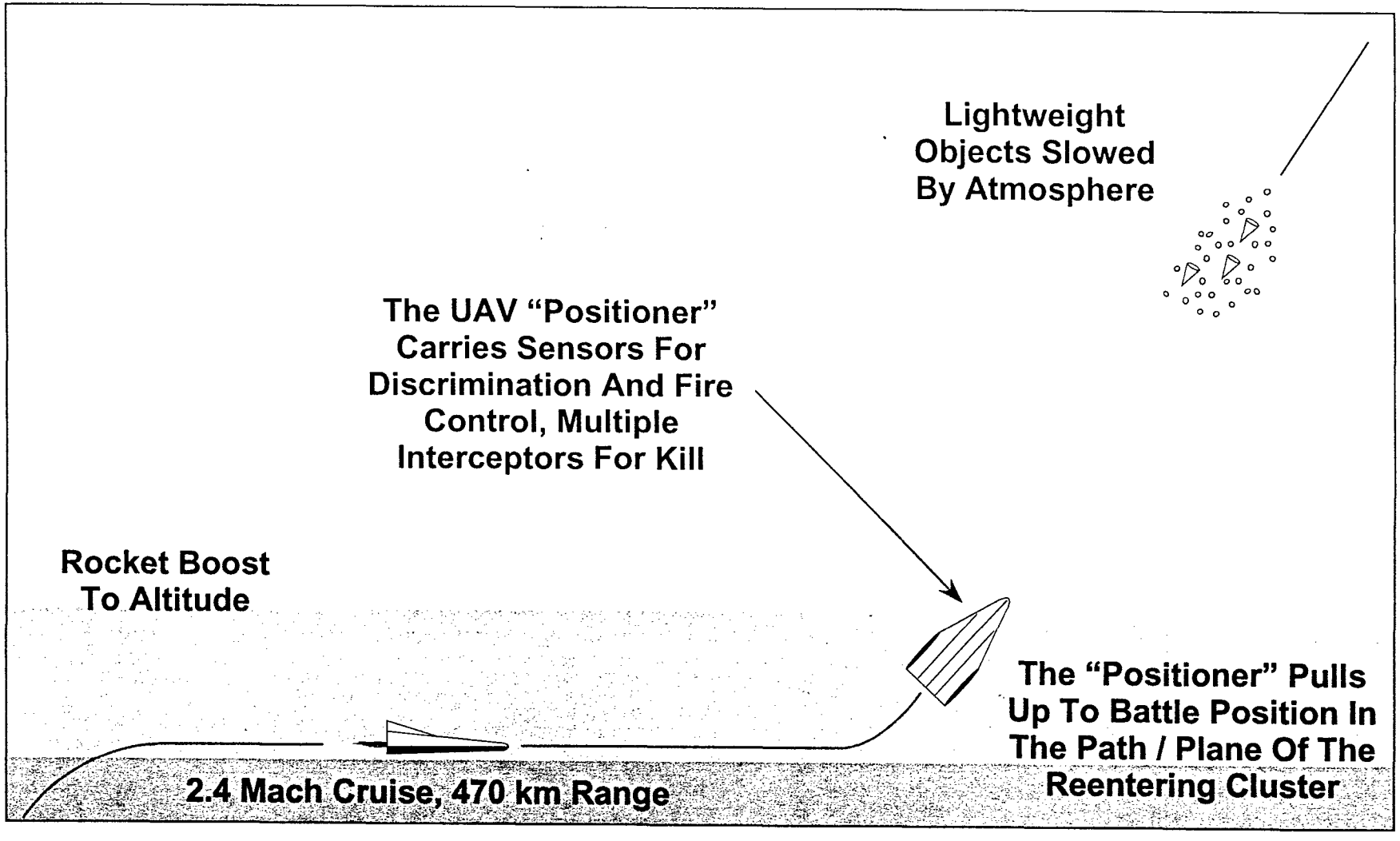
UNCLASSIFIED

TERMINAL MISSILE DEFENSE

- **Extended Footprint for Upper Tier Systems**
  - Demonstrate Capability to Increase Defended Area of THAAD Through the Development of Strapdown IR Seeker, Solid DACS, Batteries and Composite Structures.
- **Long Range Atmospheric Defense**
  - Investigate an Innovative Concept to Increase Defended Area with a High Speed, Long-Range Interceptor Operating in the Atmosphere

UNCLASSIFIED

LONG-RANGE ATMOSPHERIC INTERCEPTORS



mj-53379A / 071801

UNCLASSIFIED

MIDCOURSE SEGMENT PROGRAM PLAN

Technology Segment

- Implement Complementary, Capability-based, Block Upgrade Midcourse Development

- Ground-based:
  - Include Robust Counter-countermeasure Program
  - Implement Test Infrastructure Improvements Netted Into An Operational Test Bed
  - Could Make Available A Rudimentary Ground-based ICBM Defense Contingency Capability By 2004
  - Achieve Ground-based Capability By 2006

- Sea-based: Begin Concept Development For Expanded Midcourse Capability Including Sea-based Ascent Phase Intercepts
  - Continue AEGIS LEAP Intercept (ALI) Flight Testing
  - Provide Rudimentary Sea-based MRBM Defense Capability
  - Leverage Boost Phase Propulsion And Kill Vehicle Risk Reduction Activities
  - Leverage Midcourse Ground-based Propulsion, Kill Vehicle, BM/C^2 And Test Infrastructure
  - Achieve Navy Theater Wide IRBM Or ICBM Capability By 2008 / 2010

UNCLASSIFIED

MIDCOURSE COUNTER-COUNTERMEASURES (CCM)

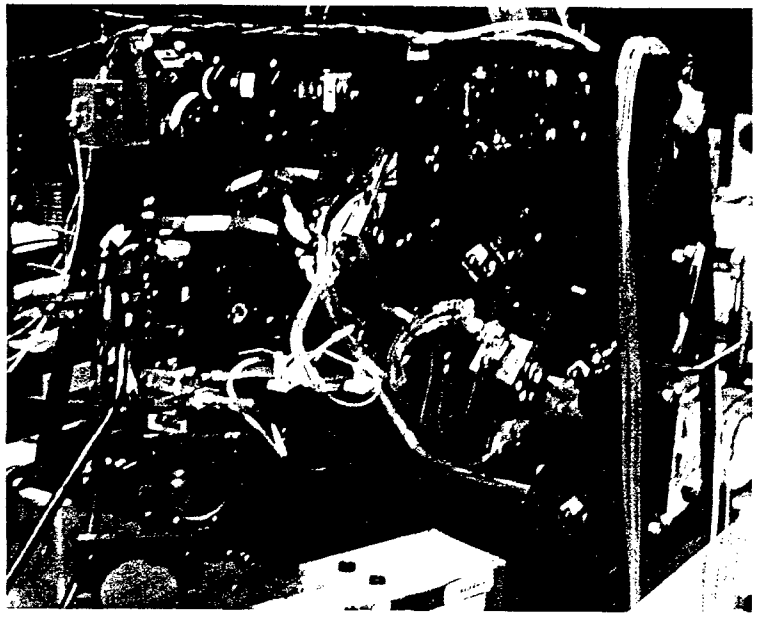
Technology Segment

- **Discriminating Seeker**
  - Demonstrate Capability To Discriminate RVs From Advanced Countermeasures Based on Temperature, Shape and Dynamics
  - Integrate Multi-Spectral IR FPAs, Ultra Compact Laser Radar and a High-Speed Miniature Fusion Processor
- **Interactive Discrimination**
  - Explore Novel Methods of Discrimination Including Momentum Transfer and Thermal Tagging
- **Transportable Discriminating Radar**
  - Demonstrate a Lightweight Radar with the Capability of Discrimination in the Early Ascent Phase
  - Integrate Wide Bandgap T/R Modules, MEMS, Adv Digital Receiver and Lightweight Antenna with Improved Power Generation and Thermal Management Systems
- **Miniature Kill Vehicles (MKV)**
  - Demonstrate an MKV Capability For Cost-Effective Negation of Multiple Objects

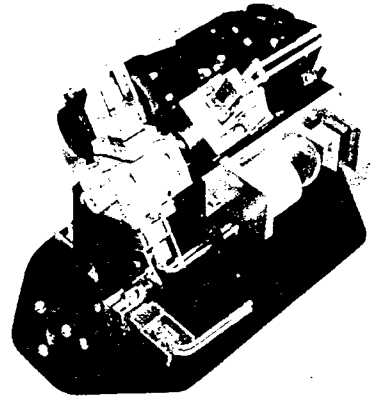
UNCLASSIFIED

LADAR DEVELOPMENT FOR INTERCEPTOR SEEKER

ADLT Compact Breadboard
- First Portable RRDI Ladar
- Indoor/Outdoor Testing
- Short Wavelength (1 μm)



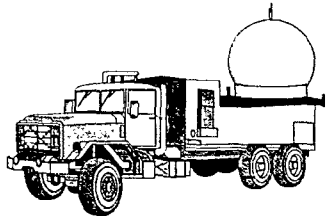
ADLT Compact Flight Unit
- Miniature Opto-mechanical Design (Laser, Receiver, Pointing)
- Airborne or Space Flight Testing
- Full Discrimination Performance

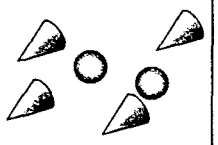


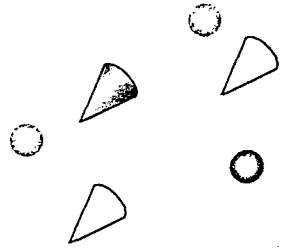
UNCLASSIFIED

TRANSPORTABLE DISCRIMINATING RADAR (TDR)

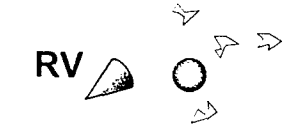
Technology Segment

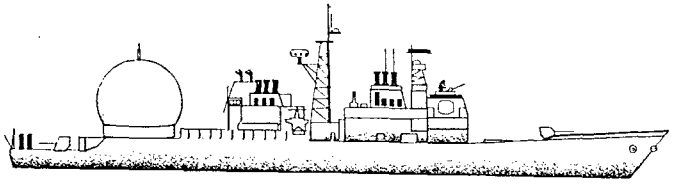


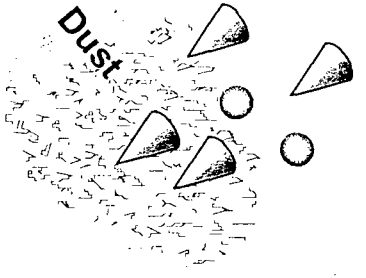




- TDR Can Track And Discriminate Early In Ascent Phase







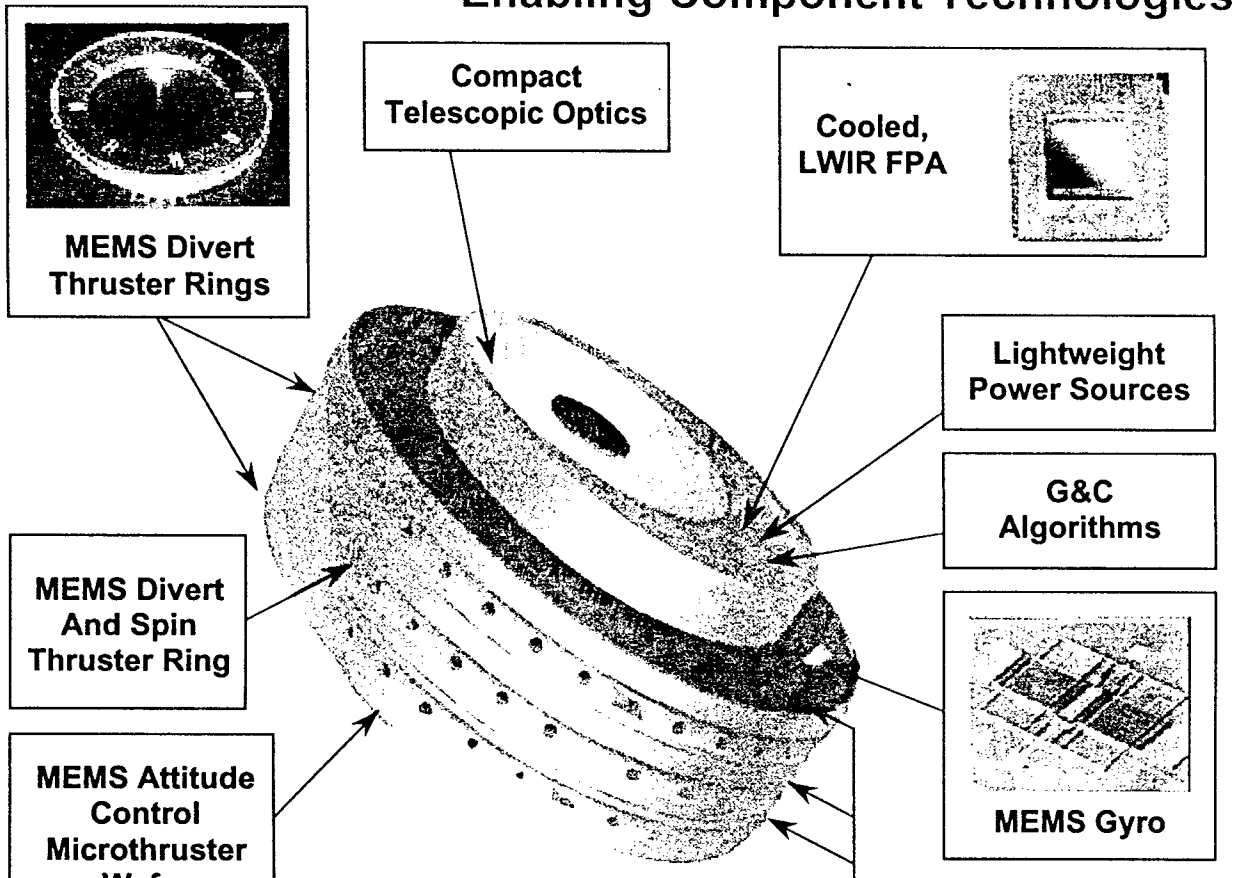
- TDR Can Measure Interactive Slowdown
- TDR Can Measure Induced Macro And Micro Dynamics (Coning / Wobble)

mj-101349 / 071801

UNCLASSIFIED

MINIATURE KILL VEHICLE (MKV) CONCEPT

Enabling Component Technologies



Physical Characteristics

- Subkilogram Mass
- Size Of A "Softball"
- < 10 cm Diameter
- < 6 cm Length
- Efficient Shape

Performance Requirements

- Spinning Projectile
- Narrow FOV (~2-4 deg)
- 20-40 km Acquisition Range
- 50-100 m/s Δv
- Very Small Miss Distances

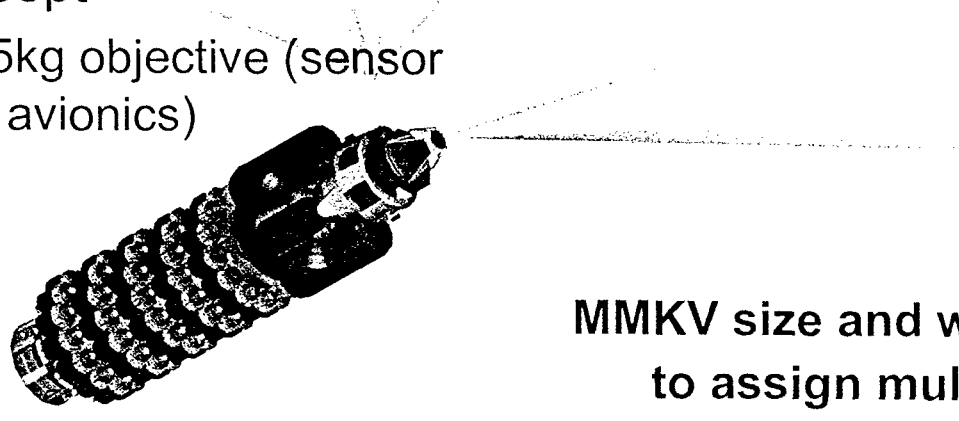
Miniature Interceptor Technology

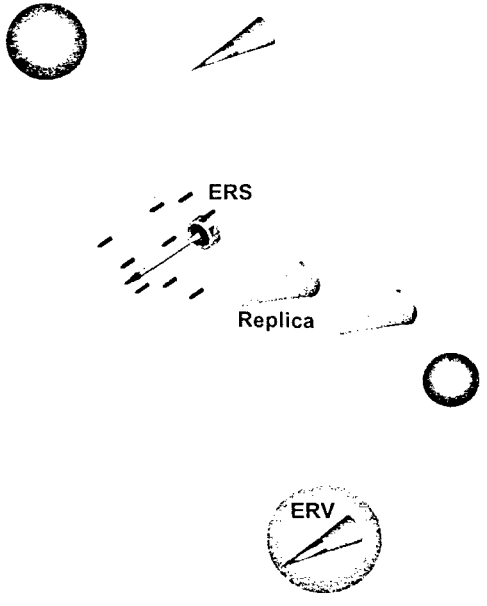
UNCLASSIFIED

BUS SENSOR CONCEPT

Sensor Balancing

- Acquisition Range
- Target Tracking Accuracy
- Derived from DITP concept
  - 25kg objective (sensor & avionics)





MMKV size and weight provides opportunity to assign multiple KVs to each object

Balance Bus Sensor with KV Sensor

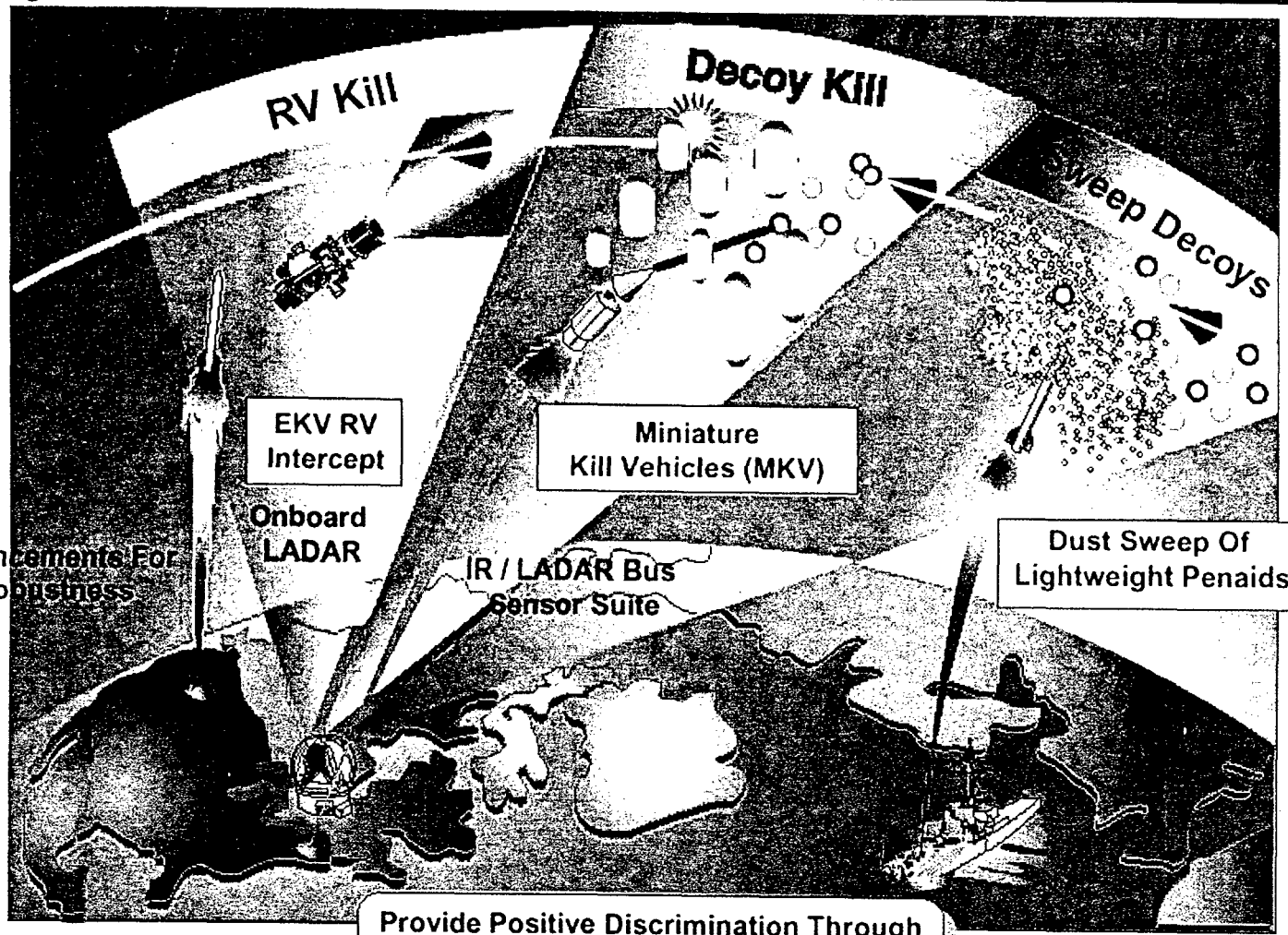
Balance Bus Handover with KV GNC

Continued Coordination with REDEAM Study

UNCLASSIFIED

MIDCOURSE ENGAGEMENT CONCEPTS

Technology Segment



UNCLASSIFIED

mj-101348 / 071801

BOOST SEGMENT PROGRAM PLAN

Technology Segment

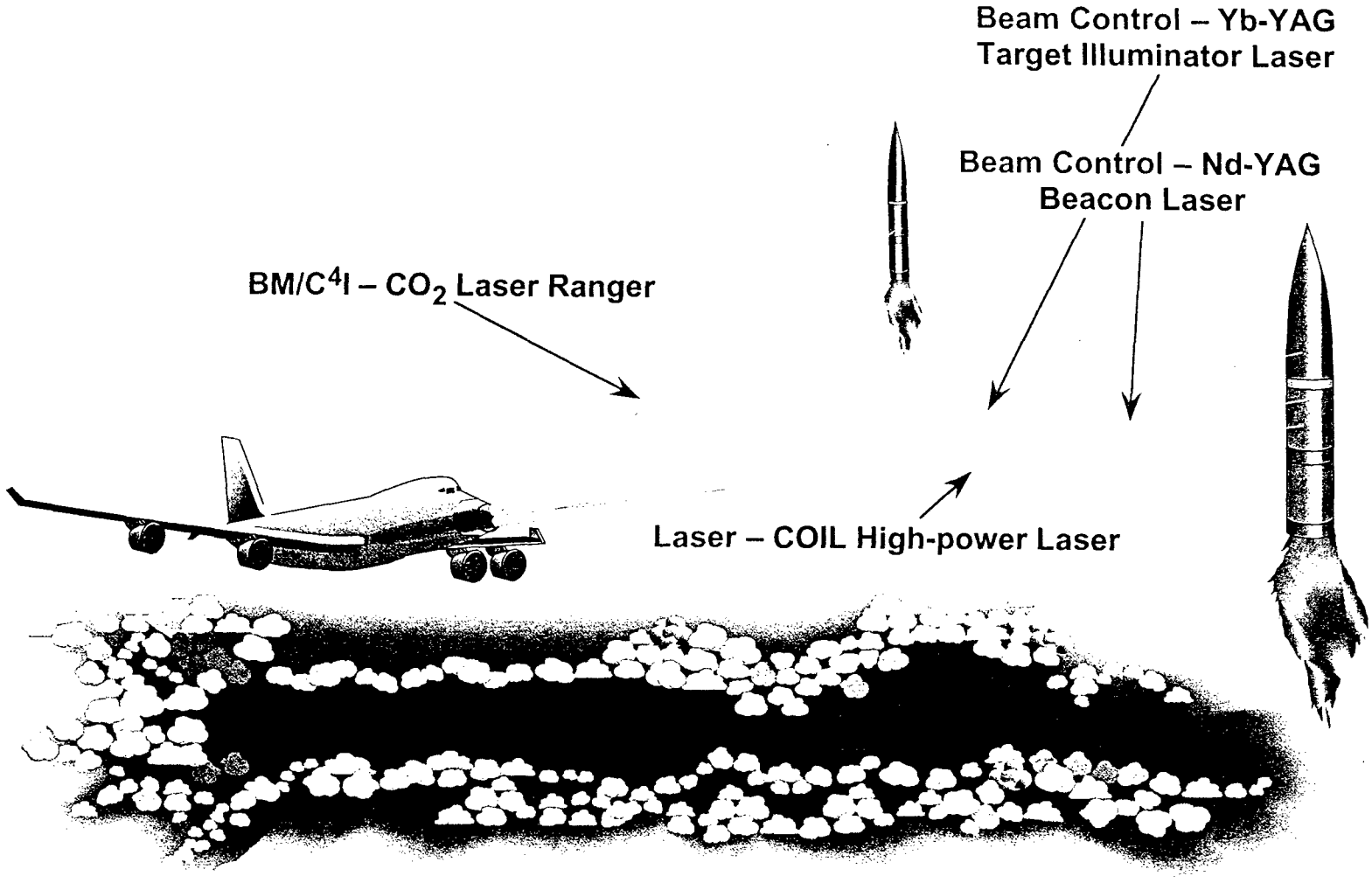
- Demonstrate And Field Airborne Laser
  - Could Make Available Emergency Capability (Block 2004)
  - Initial Capability (Block 2008)
- Define Sea-Based Boost Defense Concept Over 2-4 Years
  - Reduce Technical And Programmatic Risks (2004)
  - Prepare For Product Line Decision (2003-05)

- Define Space-Based Boost Defense Concept Over 2-4 Years
  - Reduce Technical And Programmatic Risks(2004-05)
  - Prepare For Product Line Decision (2003-05)
- Conduct Space-Based Kinetic Energy Experiment (2005-06)
- Conduct Integrated Flight Experiment Of Space-Based Laser by 2012

UNCLASSIFIED

ABL HAS FOUR LASERS

Technology Segment

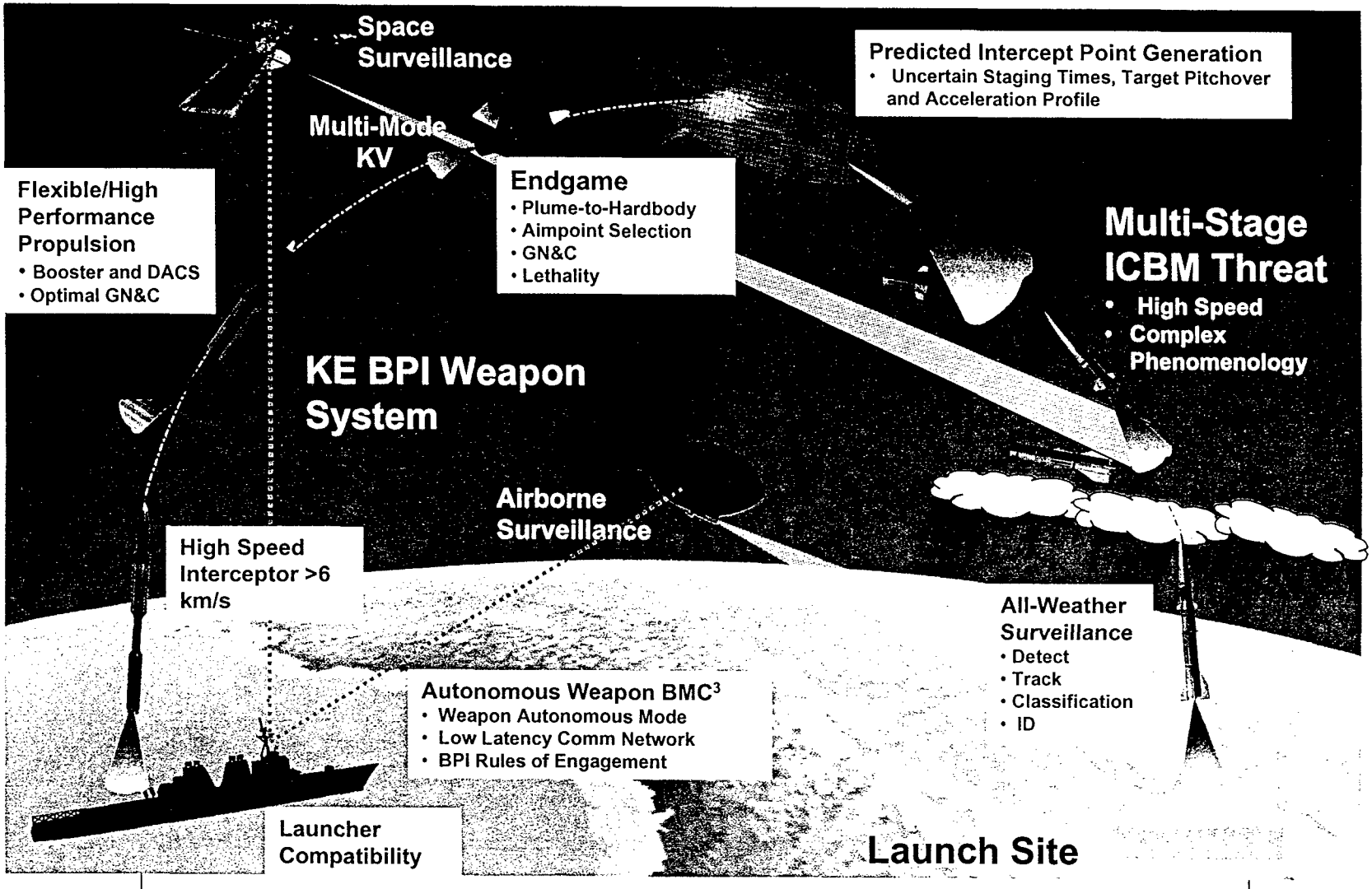


mj-101452 / 071801

UNCLASSIFIED

KE BPI TECHNICAL ISSUES

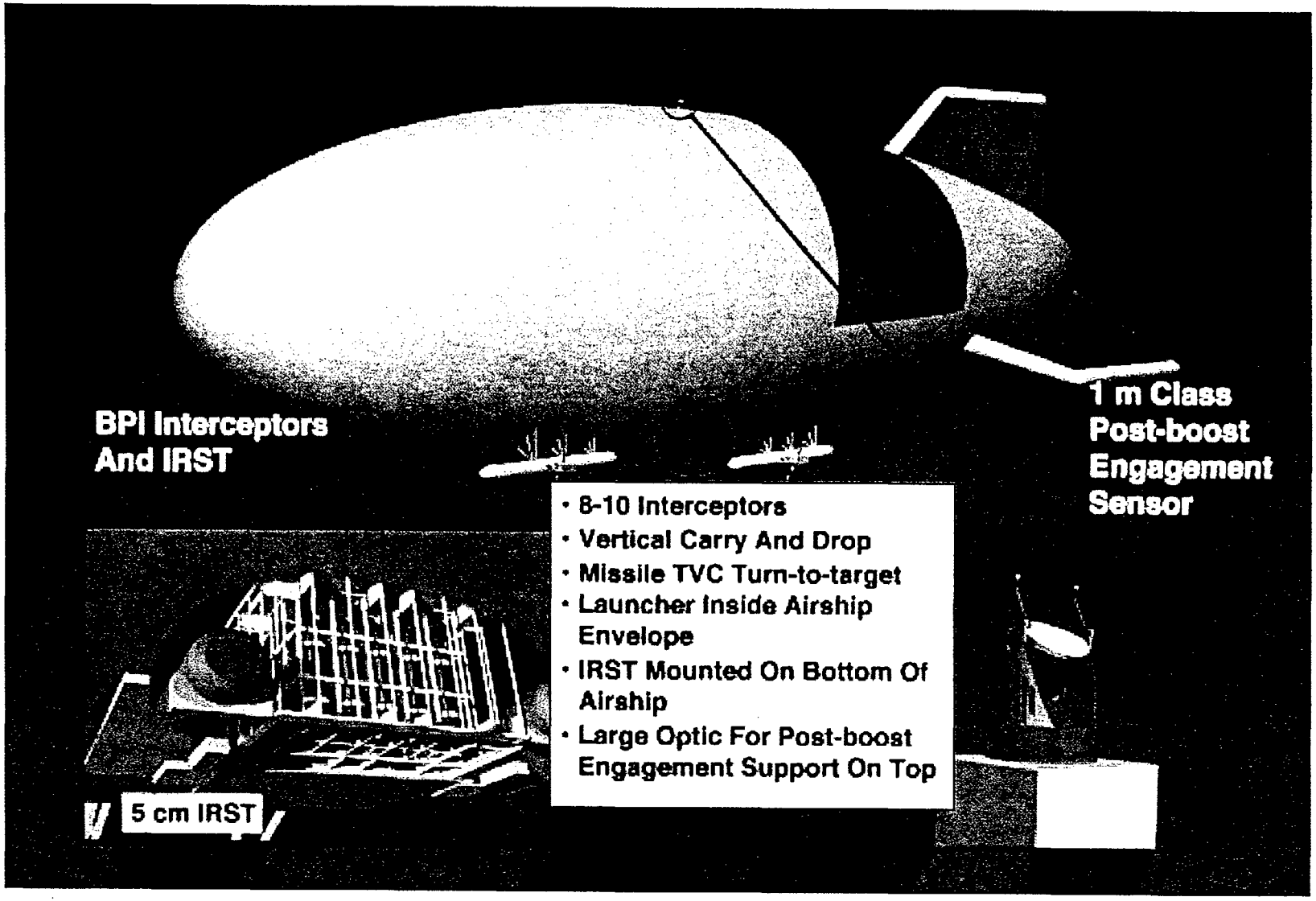
Technology Segment



UNCLASSIFIED

AIRSHIP CONFIGURATION

Technology Segment



UNCLASSIFIED

GLOBAL DEFENSE

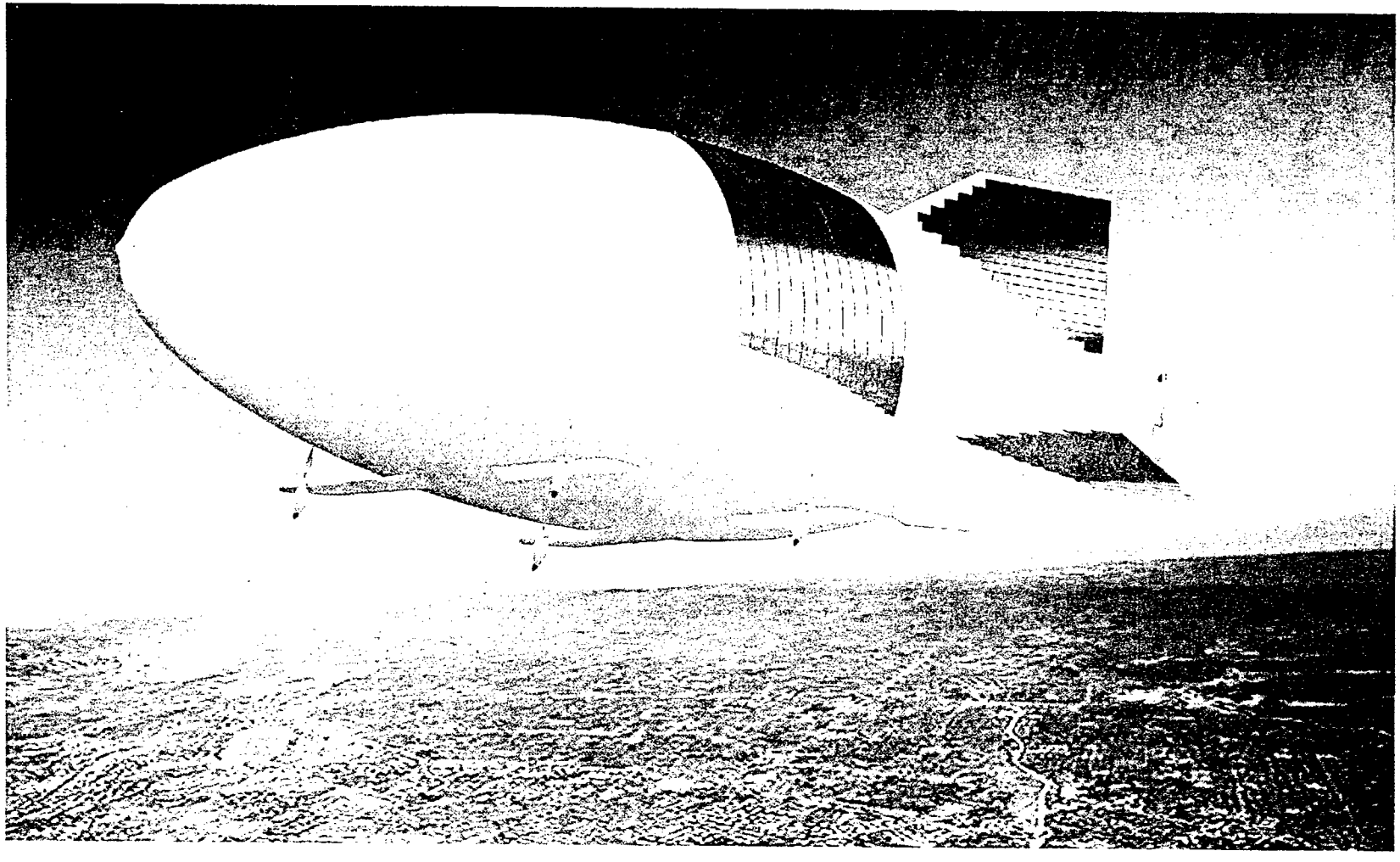
Technology Segment

- Space Based Passive Surveillance (Support to SBIRs-Low)
  - Higher Resolution Optics
  - Increased Sensitivity Focal Plane Arrays
  - Long Life Cryocoolers
- Space Based Active Tracking System
  - Bifocal Relay Mirrors
- Airship Sensor
- Space Based Interceptor (SBI) Concept Development
- Technology Development for Space Based Laser System Concept
  - Deployable Optics
  - Advanced Jitter Control

UNCLASSIFIED

MIDCOURSE AIRSHIP

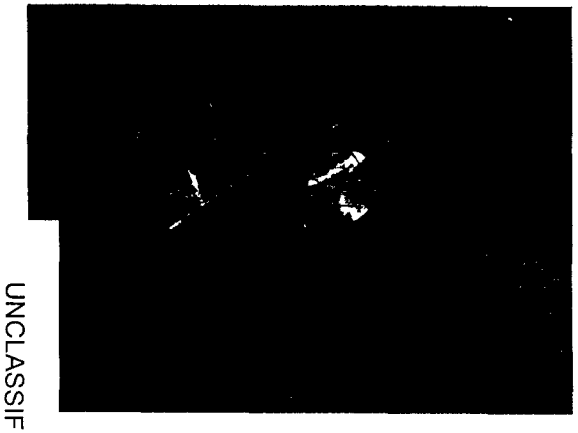
Technology Segment

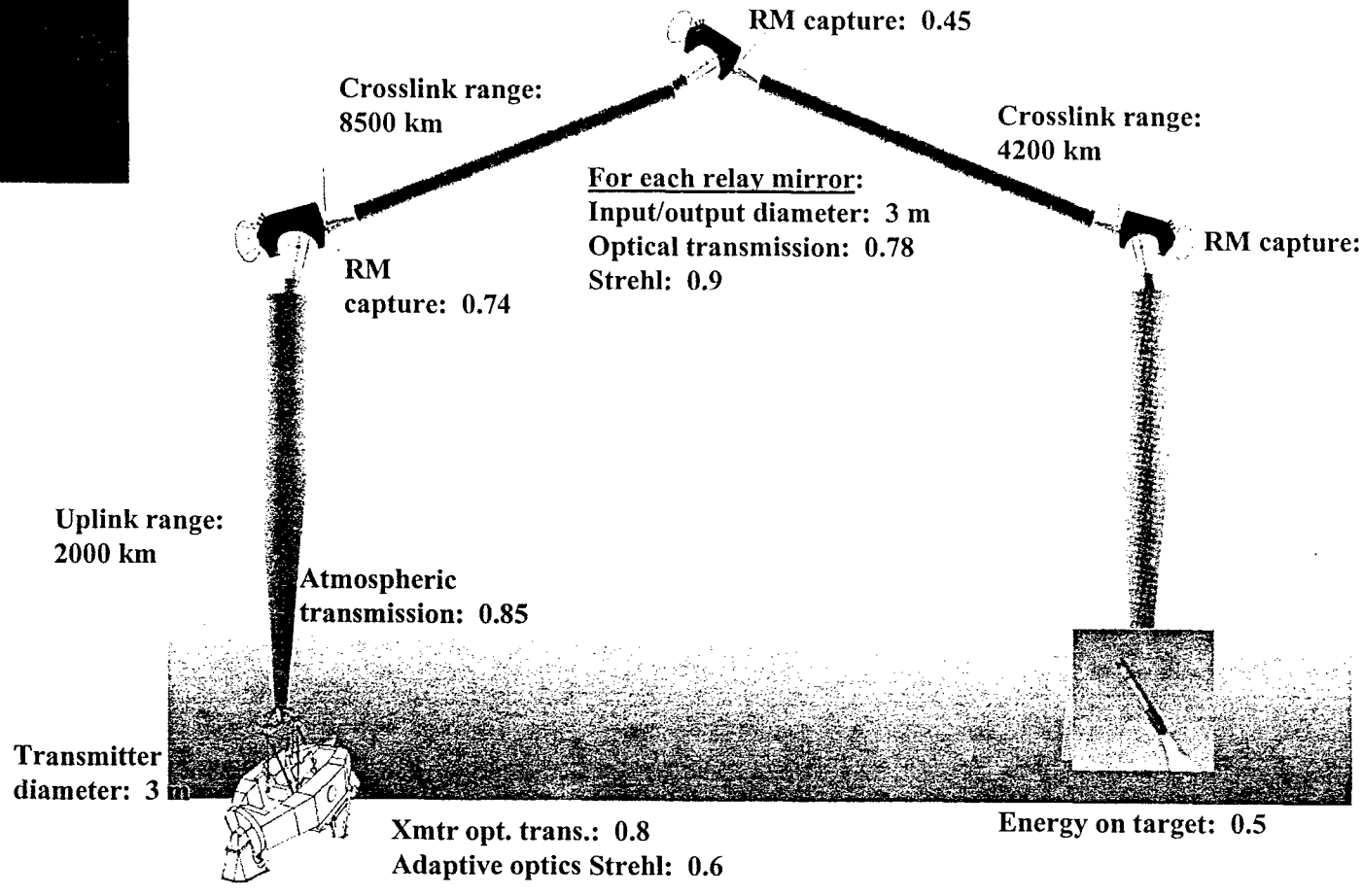


UNCLASSIFIED

SPACE RELAY MIRRORS

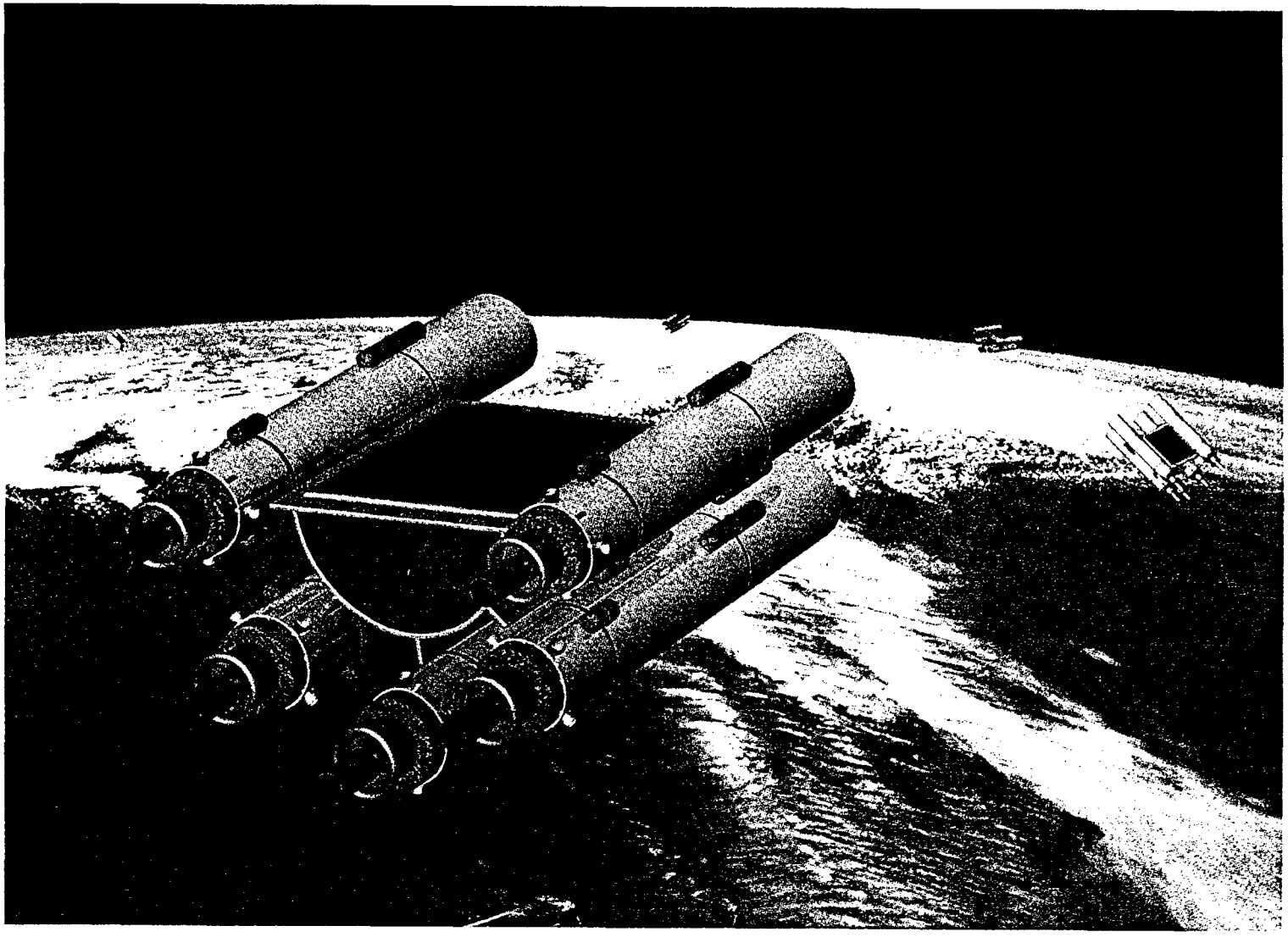
Technology Segment





SPACE BASED INTERCEPTOR CONCEPT

Technology Segment

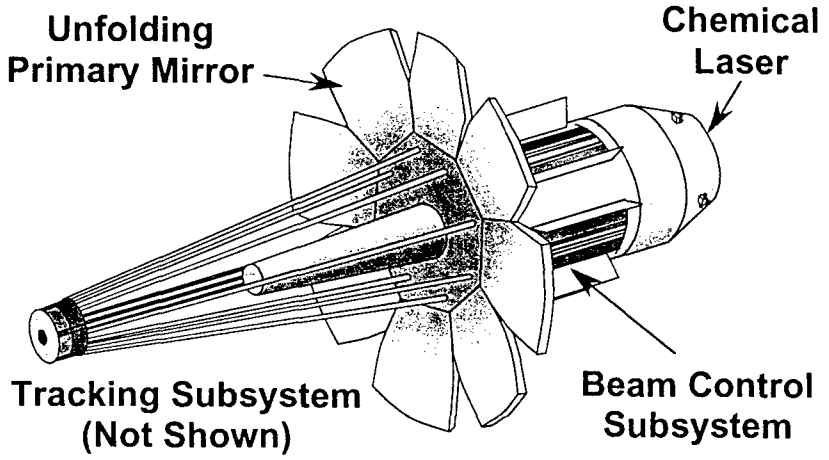


UNCLASSIFIED

SPACE BASED LASER (SBL) SYSTEM

Technology Segment

Notional Space Vehicle



Mission

- Boost Phase Intercept Capability For Global Continuous Ballistic Missile Defense

System Issues

- Affordability
- Launch Vehicle (Size / Weight)
- Integrated Flight Experiment (IFX)

Technology For Operational System

- Lightweight Deployable Mirrors
- High Energy Laser At Shorter Wavelength
- Extraordinary Jitter Control
- Advanced Acquisition, Tracking And Pointing Subsystem (ATP)

mj-82533E / 071801

UNCLASSIFIED

ENABLING TECHNOLOGY SUPPORT

- **Advanced Technology**
  - Radar
  - Multi-application FPAs
  - Materials, Structures and Power
  - Space Experiments
- **Applied Research**
  - Innovative Science & Technology
  - Interceptor/Surveillance Applied Research
- **Statutory & Special Interest Programs**
  - SBIR
  - HBCU/MI
  - Technology Applications
  - Congressional Interest Projects

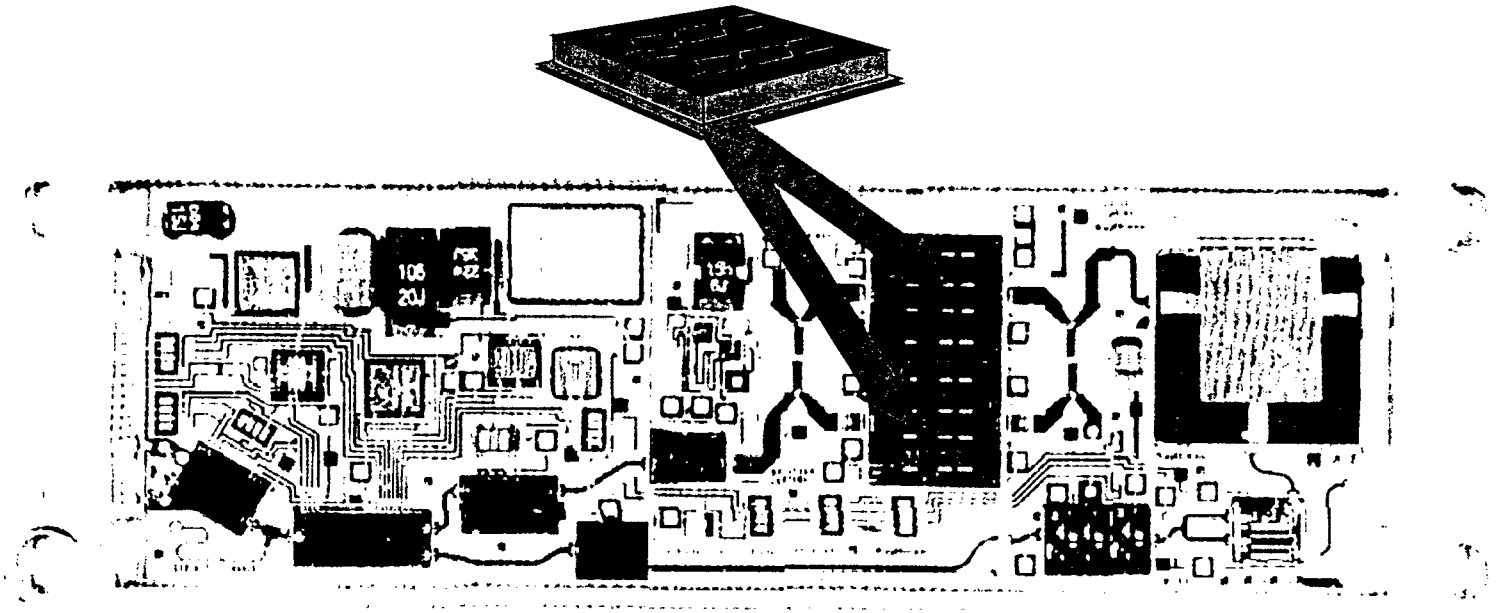
UNCLASSIFIED

WIDE BANDGAP TECHNOLOGY

Technology Segment

Electronic And Photonic Materials

Wide Bandgap Materials For High Performance Radar Systems



Gallium Nitride Power Amplifier

- Projected 2 To 4X Increase In Radar Range
- 8X Increase In Power Density

UNCLASSIFIED

BMD'S SMALL BUSINESS INNOVATIVE RESEARCH (SBIR) PROGRAM

Technology Segment

BACKGROUND

- Mandated At Not Less Than 2.5% Of Agency's Extramural RDT&E Funding
- Cannot Use Non-SBIR Awards To Meet SBIR Goals
- Program Structure
  - Phase I Feasibility – Maximum Award $100K for Six Months (Avg. is $65K)
  - Phase 2 Development – Maximum Award $750K For Two Years

ISSUES

- Management Resources Needed To Track Several Hundred Awards Each Year
- Payoff To BMDO Not Clear
  - Component Level Work (Proposed By Small Business') Difficult To Connect To Major Projects (Under Development By Prime Contractors)
  - Program Emphasis Is Industrial Commercialization First (High Volume, High Profits), Then Military Application
- Program Now Dominates BMDO (Discretionary) Investments in Technology

FY 00	FY 01	FY 02
$60M	$90M	$154M (Projected)

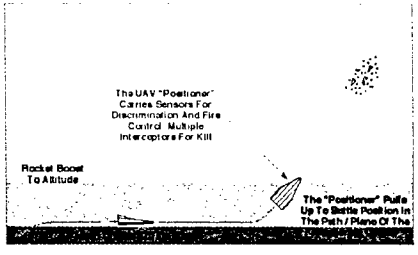
UNCLASSIFIED

REVOLUTIONARY CONCEPTS / CAPABILITY

Technology Segment

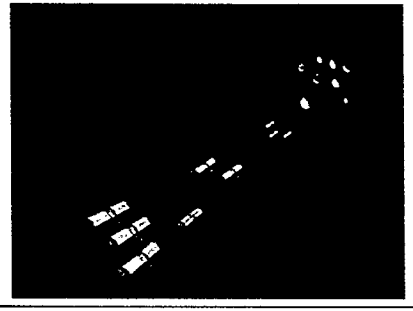
Regional Defense Of Allies

High-speed Interceptor Can Be Driven Through The Atmosphere To A Point In Front Of A Threat Cloud. Engagement Of RV Takes Place After The Atmosphere Filters The Associated Penaids



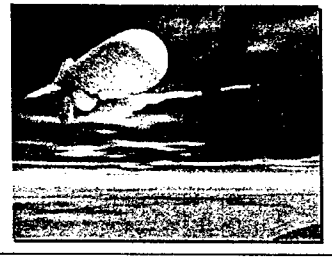
Miniature Kill Vehicles

Mini-KVs Are Smart Bullets Delivered By A Carrier Vehicle Then Released To Engage Incoming Threats (RVs And Decoys)



Air Based NMD Sensors And Weapons

Air Ship Can Carry Sensors For Midcourse Surveillance Or Be Configured To Carry Sensors And Weapons For Boost Phase Engagement

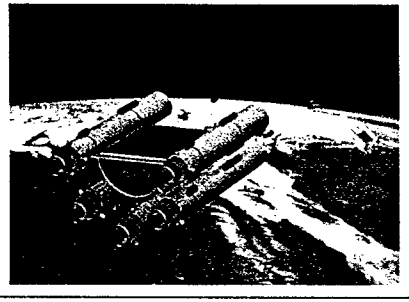


Space Relay Mirrors

A Constellation Of (Bifocal) Relay Mirrors In Space Can Be Used To Direct Laser Beam For "Birth To Death" Tracking Of An RV. Potential Also For Boost Engagement Using A Ground HEL

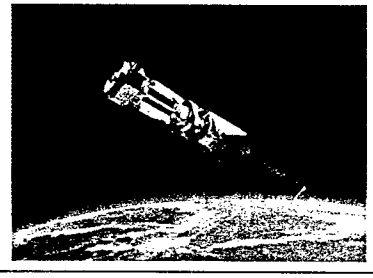
Space Based Interceptor (SBI)

Modern Design Of Space Platform Capable Of Launching Multiple Kinetic Energy Interceptors



Space Based Laser (SBL)

Concept Of Space Based High Energy Laser System To Engage Ballistic Missile Threats In Boost Phase



SUMMARY OF BALLISTIC MISSILE DEFENSE TECHNOLOGY TRENDS

Technology Segment

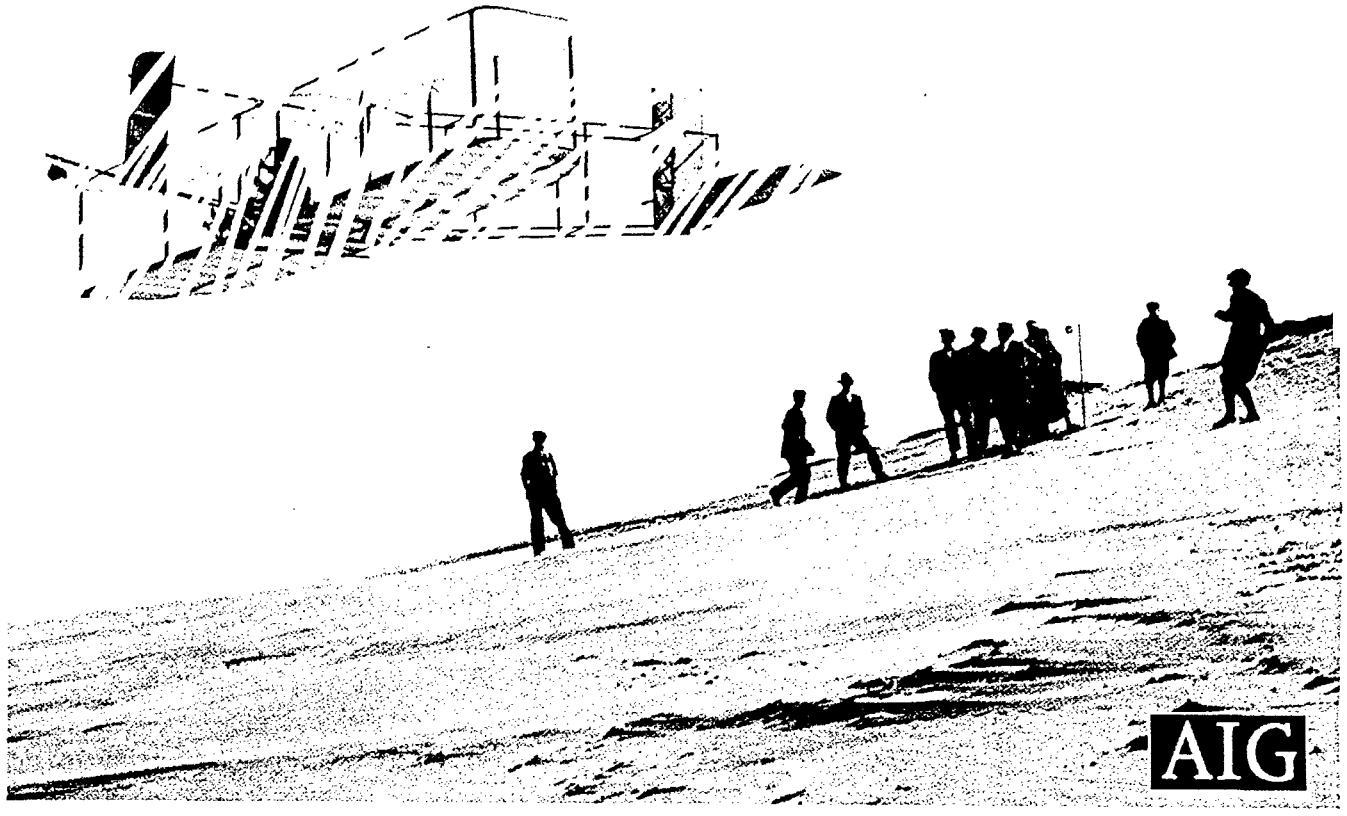
- COMPONENT LEVEL
  - Miniaturization Leading to the Downsizing of All Sensors and Weapons
- SYSTEM LEVEL
  - Today's Passive Electro-Optical Sensors Enhanced by LADAR Systems
- WEAPON TYPE
  - More Emphasis on Directed Energy
- PLATFORMS
  - More Emphasis on Space Systems

UNCLASSIFIED

THE GREATEST RISK IS NOT TAKING ONE

Technology Segment

It takes courage to do something that's never been done before. To attempt a feat that goes beyond conventional thinking. But, it also takes planning and a complete understanding of all the problems that may arise. No one has a better firsthand knowledge of the inherent risks of daring enterprises than we do... So the next time you wake up, mind ablaze with an idea that nobody's attempted to pursue before, contact BMDO/ST. We're the segment that helps challenging ventures gets off the ground



UNCLASSIFIED